

## RESEARCH ARTICLES

### Pharmacy Students' Reading Ability and the Readability of Required Reading Materials

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**Objective.** To determine the reading level of third-professional year doctor of pharmacy students and whether a significant correlation existed between Nelson-Denny Reading Test (NDRT) grade equivalence scores and the Pharmacy College Admission Test (PCAT) percentile scores, and to determine the reading level of selected course materials.

**Methods.** The NDRT was administered to third-professional year (P3) pharmacy students. Scores from the NDRT were compared to the percentile rankings of the students' PCAT scores to determine whether significant correlations existed. Chapters from a pharmacy textbook and published medical guidelines were assessed using the Gunning FOG readability formula.

**Results.** Based upon the NDRT, the average reading grade level for pharmacy students was 16.5 years. There was a strong correlation between the vocabulary scores from the NDRT and the PCAT verbal percentile ( $\rho = 0.776$ ,  $p < 0.001$ ). The average readability grade level of the materials assessed was 18.0 years for the textbook and 19.2 years for the medical guidelines.

**Conclusions.** The verbal PCAT percentiles strongly correlate with the vocabulary grade equivalence scores on the NDRT. A moderate correlation was found between the composite PCAT percentiles and NDRT total grade equivalence scores. There was also a disparity between the average reading level of the students and that of the reading samples that were assessed.

**Keywords:** reading ability, Nelson-Denny Reading Test, admissions

## INTRODUCTION

Seventy percent of college students do not read required materials before class.<sup>2</sup> Many of today's college students are poor readers and may not be prepared to read at the level necessary to fully comprehend complex textbooks and primary literature required in many courses.<sup>1,2</sup> At higher levels of education, such as in medical or pharmacy schools, student reading demands increase and the readability of medical literature becomes more difficult.<sup>2-4</sup> Combined, these factors can result in poor reading comprehension and may affect academic performance.

The Nelson-Denny Reading Test (NDRT) has often been used to assess the reading ability of students at higher levels of education.<sup>3-4</sup> The NDRT is a standardized test that assesses a student's reading ability in 3 areas: vocabulary, reading comprehension, and reading rate.<sup>5</sup>

When the NDRT is administered, raw scores are calculated for vocabulary, reading comprehension, reading rate, and total score. The total score is derived by com-

binning the vocabulary and reading comprehension scores. Raw scores obtained from the test are converted into grade equivalents using the NDRT scoring manual.<sup>5</sup> Grade equivalent scores (NDRT GE) report the grade level at which a student is performing according to the NDRT. For example, if student A, an eleventh grader, received a NDRT GE score of 9.5 in reading comprehension, her performance in reading comprehension was comparable to that of students in the middle of their ninth grade year. The NDRT total GE score represents the average overall grade performance on the NDRT and is more highly correlated with student performance than either of the vocabulary or reading comprehension GE scores individually.<sup>5</sup>

The NDRT has been used to screen students with both poor and superior reading assessment skills to assist in the placement of students in the appropriate classes. The University of Minnesota has screened incoming freshman and has shown that new college students scoring in the 35th percentile or less usually had academic difficulties during their college career. The NDRT has also been used at several universities to predict student performance in business, English, political science, and biology coursework.<sup>5</sup>

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In addition to assessing the reading skills of students, many institutions evaluate the readability of textbooks and required materials to ensure that they are written at an appropriate level for the intended audience. Readability formulas such as the Flesch, and Gunning FOG Index (SMOG) are based upon sentence architecture. These formulas consider word and sentence length, with sentences containing more multisyllabic words becoming more difficult to read.<sup>6-9</sup> The Gunning FOG Index was developed by Robert Gunning, who founded the first consulting firm specializing in readability in 1944. The formula was developed using a 90% correct score with the McCall-Crabbs reading tests, which gives the formula a higher grade criterion than many other formulas.<sup>8,9</sup> The Gunning FOG readability formula has been used to determine the readability of various texts and correlates well with the comprehension of the material tested ( $r = 0.62$  to  $0.90$ ).<sup>6</sup> The Gunning Fog formula is as follows<sup>6-9</sup>:

$$\text{Grade Level} = 0.4 \left( \begin{array}{l} \text{average} \\ \text{sentence} \\ \text{length} \end{array} + \begin{array}{l} \text{percentage} \\ \text{of words} \\ \text{more than} \\ \text{2 syllables} \end{array} \right)$$

Both the NDRT and the FOG readability tests have been used to predict academic performance and the appropriateness of selected readings of healthcare students.<sup>5-7,9</sup>

Several authors have assessed the reading skills of medical students using the NDRT.<sup>3,4,6</sup> Positive correlations ( $r = 0.51$  to  $0.69$ ) have been found between the Medical College Admissions Test (MCAT) reading scores and the total scores from NDRT.<sup>3,4,10</sup> In addition, NDRT scores, when compared to MCAT scores, are a better predictor of performance on part 1 of the United States Medical Licensing Examination (USMLE).

McCabe et al also used the NDRT to assess the reading comprehension skills of dietetic interns and the Gunning FOG readability test to evaluate the readability of dietetic literature.<sup>11</sup> The authors reported a discrepancy between the reading comprehension skills of the interns and the readability of the complex medical literature.<sup>11</sup> Weeks and Wallace reported that selected articles from the *Journal of the American Medical Association* read at a grade level of  $17.8 \pm 1.3$  when assessed with the FOG index.<sup>7</sup> Roberts and colleagues reported that after peer evaluation of selected articles published in *Annals of Internal Medicine*, the articles read at a grade level of  $16.85 \pm 1.42$ .<sup>6</sup>

Even though a discrepancy may exist between the reading levels of healthcare students and the materials they are assigned to read,<sup>6,7</sup> there is little information evaluating the reading assessment skills of pharmacy stu-

dents and the readability of required reading materials in pharmacy school curricula. The assessment of prepharmacy students' reading skills occurs during the Pharmacy College Admission Test (PCAT). Similar to the NDRT, the PCAT evaluates reading comprehension and vocabulary skills. Literature assessing the correlation between PCAT scores and student performance in pharmacy school have reported various results. Thomas and Draugalis found the PCAT to be a good predictor of first-professional year student performance.<sup>12</sup> Chisolm et al did not find the PCAT to be a predictor of academic success in the first year of pharmacy school.<sup>13</sup> McCall et al found significant correlations between PCAT scores and NAPLEX results with the Composite PCAT score being a strong predictor of NAPLEX success or failure.<sup>14</sup> Although the PCAT will provide a baseline indication of student abilities in various categories prior to entering pharmacy school, the PCAT is not used to monitor changes in students' reading abilities throughout the pharmacy curriculum, while the NDRT can be used in this fashion.<sup>5</sup> NDRT scores predict academic success for medical students; it is not known if similar results can be expected with pharmacy students.

In the same manner, evaluating readability of required reading materials for pharmacy students may help faculty identify materials which may pose problems in regard to comprehension. At Campbell University, the therapeutics course during the P3 year requires that students read the text *Pharmacotherapy: A Pathophysiologic Approach*,<sup>15</sup> as well as the primary literature articles assigned for each session by the faculty members.<sup>16-21</sup> The course is case-based and meets 3 to 4 times each week for 2-3 hours. The course helps prepare students for their fourth-professional year (P4) advanced pharmacy practice experiences (APPEs) by requiring the reading of essential primary and tertiary literature.

This study had 3 objectives: (1) determine the reading level of pharmacy students in the third-professional year of pharmacy school at Campbell University School of Pharmacy (CUSOP) using the Nelson-Denny Reading Test (NDRT), (2) determine if there is a correlation between the NDRT grade equivalent (NDRT GE) scores and the subjects' Pharmacy College Admissions Test (PCAT) percentiles, and (3) assess the readability of selected chapters out of the textbook *Pharmacotherapy: A Pathophysiologic Approach*,<sup>15</sup> as well as published medical treatment guidelines,<sup>16-21</sup> using the Gunning FOG readability formula.

## METHODS

The Campbell University School of Pharmacy (CUSOP) curriculum requires successful completion of

4 professional years of pharmacy school in addition to 2 years of prepharmacy courses. Each professional year class contains approximately 100 students. The P3 class at CUSOP was chosen as the subjects for this study because their required readings were more directly related to clinical therapeutics. The study was conducted during a regular class period in the spring semester. On the day of the study, participating students were given a survey instrument which asked questions regarding gender, prior undergraduate degree, primary language, race, and parents' education. The research instrument (NDRT- Form G) was then administered.

The NDRT provides vocabulary and reading comprehension scores, a reading rate, and the total score. The vocabulary portion of the test consists of an evaluation of 80 definitions, with 5 different vocabulary word choices following each definition. The reading comprehension portion contains 7 different reading passages on topics such as humanities, social sciences, and general sciences. There are a total of 38 multiple-choice questions with a specific number of questions following the different passages. Time limits for the vocabulary and reading comprehension components of the test are 15 minutes and 20 minutes, respectively.<sup>5</sup>

For this study, the raw NDRT scores for vocabulary, reading comprehension, and total scores were converted to grade equivalent scores. This was done to facilitate comparison between the NDRT scores and the FOG readability scores, which are also reported as grade equivalents. The NDRT Manual for Scoring and Interpretation provides the information needed for score conversion.<sup>5</sup>

After the NDRT was completed, the readability of selected P3 materials was assessed. Printed written reading samples were taken from selected chapters in *Pharmacotherapy: A Pathophysiologic Approach*.<sup>15</sup> This is the primary textbook students use throughout the therapeutics courses at CUSOP. Nine chapters, which covered disease states such as hypertension, hyperlipidemia, and diabetes mellitus, were chosen from the textbook. Published medical treatment guidelines were also assessed.<sup>16-21</sup> The reading selections were chosen based on input from the investigators and other faculty members from the Pharmacy Practice Department at CUSOP. The material chosen was felt to be essential for development of a foundation on which the clinical skills of the subjects could be built throughout the remainder of the curriculum. Individual passages from the selections were randomly selected for evaluation by the primary investigator.

These written materials were analyzed utilizing a computer software program Readability, version 7.0 (Micro Power and Light Company, Dallas, Tx).<sup>22</sup> This software offers 9 different readability formulas. Of the 9

formulas, the Gunning FOG formula was utilized because of its previous use in studies to assess medical text.<sup>6,7</sup> Roberts and colleagues reported that a document with a reading grade level of 5 is very easy to read and a document with a grade level of >16 is very difficult to read and comparable to a legal document.<sup>6</sup>

SPSS, version 15 (Statistical Package for the Social Sciences, Cary, NC) was used for the statistical analysis. Descriptive statistics were used to evaluate/assess demographic data. Spearman's rank order correlation coefficients were calculated between reading, verbal, and composite percentiles from the PCAT and NDRT GE scores. The Mann Whitney U test was used for comparison of mean PCAT percentiles of students scoring below the mean (<16.5) and at or above the mean ( $\geq 16.5$ ) of total NDRT GE scores. A predetermined alpha level of 0.05 was used in this study.

## RESULTS

Ninety-nine students were enrolled in the P3 class. Ninety-one students (92%) completed the study. Four students did not sign the letter of informed consent and 4 students were absent the day the test was administered. Table 1 presents the demographic profile of the students that took the NDRT. The majority of students were Caucasian, female, and spoke English as their primary language. The number of students that had a prior 4-year college degree was similar to the number that did not (48% vs. 52%).

Table 2 reports the NDRT Grade Equivalent (GE) scores and the percentage of students scoring at or above the mean for each category. The mean NDRT GE scores ( $\pm$ SD) for vocabulary was  $16.5 \pm 1.8$ , for comprehension,  $16.4 \pm 2.4$ ; and total scores  $16.5 \pm 2.0$ , which is just beyond the fourth year of college. The majority of the students scored at or above the mean for each category on the NDRT. The maximum grade equivalent that can be

Table 1. Characteristics of Third-Professional Year Pharmacy Students Participating in an Assessment of Reading Ability

Population Characteristics	Subjects, No. (%)
Female	62 (68)
Undergraduate degree: none	47 (52)
Undergraduate degree: 4-years	44 (48)
English as the primary language	81 (89)
Race	
Caucasian	77 (85)
African-American	4 (4)
Hispanic	3 (3)
Asian	2 (2)
Other	5 (6)
Parent with a college degree	56 (62)

Table 2. Nelson-Denny Reading Test (NDRT) Grade Equivalent Scores of Third-Professional Year Pharmacy Students (N = 91)\*

Area Tested	Score (Grade Equivalency)		Students, % $\geq$ Mean
	Mean (SD)	Range	
Vocabulary	16.5 (1.8)	11.6-18.9	53.8
Comprehension	16.4 (2.4)	9.3-18.9	59.3
Total Score	16.5 (2.0)	10.6-18.9	56.0

\*No significant differences were found in NDRT total grade equivalent scores (Mann Whitney U Test,  $p > 0.05$ ) in comparisons of gender, presence of undergraduate degree, English vs. non-English primary language, Caucasian vs. non-Caucasian race, and parent with or without college degree

achieved on the NDRT is a grade level of 18.9 years for vocabulary, reading comprehension, and total scores.

The demographics survey was given to determine the characteristics of the sample and to determine if there was a difference in the student's performance on the NDRT within the individual categories. No significant differences were found in NDRT grade equivalents between gender, presence or absence of undergraduate degree, English vs. non-English primary language, Caucasian vs. non-Caucasian race, or whether parents had a college degree.

Correlations of the NDRT GE scores with PCAT percentiles are reported in Table 3. The strongest correlation was found between the NDRT vocabulary GE scores and the verbal PCAT percentiles ( $\rho = 0.776$ ;  $p < 0.001$ ; Figure 1).

The NDRT total grade equivalents were divided into 2 categories: grade equivalents below the mean of 16.5 and those at or above the mean.<sup>5</sup> Table 4 compares the PCAT percentiles for these 2 groups. Students who scored at or above the mean scored significantly higher on their verbal, biology, reading comprehension, and composite

Table 3. Correlations Between NDRT Grade Equivalents and PCAT Percentile Scores of Third-Professional Year Pharmacy Students

PCAT Test Area	Reading		
	Vocabulary NDRT-GE	Comprehension NDRT-GE	Total NDRT-GE
Verbal	0.776 <sup>‡</sup>	0.553 <sup>‡</sup>	0.711 <sup>‡</sup>
Biology	0.291 <sup>†</sup>	0.138	0.247*
Reading	0.512 <sup>‡</sup>	0.420 <sup>‡</sup>	0.523 <sup>‡</sup>
Quantitative	0.061	0.317 <sup>†</sup>	0.221*
Chemistry	0.157	0.089	0.144
Composite	0.521 <sup>‡</sup>	0.435 <sup>‡</sup>	0.532 <sup>‡</sup>

NDRT = Nelson-Denny Reading Test; GE = grade equivalent;  
PCAT = Pharmacy College Admission Test

\* $p < 0.05$

<sup>†</sup> $p < 0.01$

<sup>‡</sup> $p < 0.001$

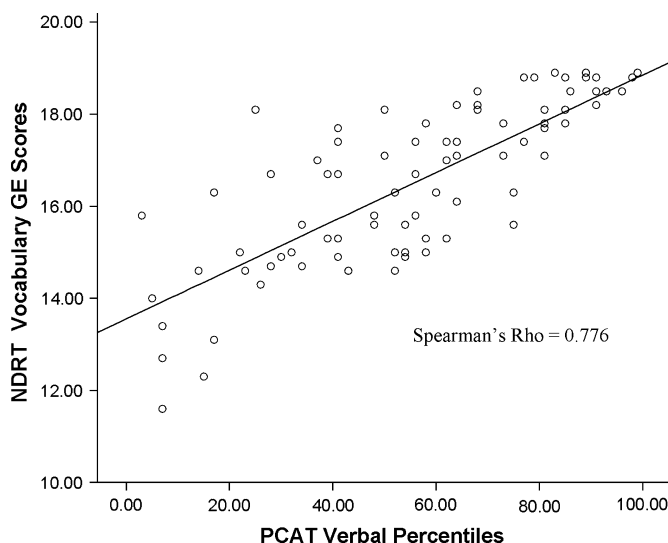


Figure 1. Correlation of NDRT Vocabulary Scores With PCAT Verbal Scores.

PCAT percentiles. Although the Quantitative and Chemistry PCAT percentiles were not significantly different for students who scored well on the NDRT ( $p > 0.05$ ), there was still a trend showing higher PCAT percentiles in these areas among students with higher NDRT scores.

In addition to evaluating student reading abilities, the readability of required materials for pharmacy students was evaluated. Based upon the Gunning FOG readability formula, chapters from the pharmacotherapy textbook<sup>15</sup> read at an average grade level of 18.1 (range 16.3-19.5) and medical treatment guidelines<sup>16-21</sup> read at an average grade level of 19.2 (range 17.5-21.0).

## DISCUSSION

The purpose of this study was to evaluate the reading comprehension skills of third-professional year pharmacy students at Campbell University, determine whether a correlation existed between these results and student PCAT percentiles, and to determine the readability of materials required for reading during the *Therapeutics* course.

The NDRT reported total GE scores of 16.5 for the third-professional year pharmacy students, with 18.9 being the highest-grade level that can be achieved on the NDRT. Although over 50% of the students scored at grade level of 16 or above, only 10 students scored at the maximum 18.9 grade level on the NDRT total score. When evaluating correlations, this study found a strong correlation between NDRT vocabulary GE scores and PCAT verbal percentiles ( $\rho = 0.776$ ,  $p < 0.001$ ). This would be expected since the NDRT vocabulary test and the PCAT verbal test are both evaluating vocabulary knowledge. This may also indicate that although the PCAT was administered prior to pharmacy school, it is still a good

Table 4. Comparison of Mean PCAT Percentiles of Students Scoring Below Mean (<16.5) and At/Above Mean ( $\geq 16.5$ ) of Total NDRT GE Scores

PCAT Area	Mean Student PCAT Percentiles (SD)		Significance (Mann Whitney U Test)
	NDRT Total Scores <16.5 (n = 40)	NDRT Total Scores $\geq 16.5$ (n = 51)	
Verbal	38.00 (19.98)	69.94 (20.35)	<0.001*
Biology	55.85 (28.55)	68.73 (21.53)	<0.05*
Reading Comprehension	43.38 (22.52)	62.44 (20.37)	<0.001*
Quantitative	41.82 (24.33)	47.86 (25.76)	>0.05
Chemistry	48.03 (25.71)	50.75 (28.76)	>0.05
Composite	44.67 (23.04)	65.35 (21.75)	<0.001*

\*Statistically significant

indicator of verbal skills 3 years into the pharmacy program since it is correlated with the NDRT vocabulary score. A similar result was found in a study conducted by Jackson and Brooks which showed a correlation of  $r = 0.51$  between NDRT total scores and reading scores from the MCAT.<sup>4</sup> Jackson et al reported a correlation of  $r = 0.69$  between NDRT and MCAT scores, with the NDRT being the best predictor of academic achievement.<sup>10</sup> The NDRT is one predictor of success for both basic science and clinical science grade point average (GPA) in medical school as well as for success on the medical board examination (USMLE).<sup>3,4,10</sup>

Our results also showed that the reading comprehension skills of CUSOP subjects (mean NDRT, total GE = 16.5) is below the FOG readability grade level of the materials they are required to read, 18.1 (text) and 19.2 (primary literature). Roberts and colleagues report that the FOG readability formula has been validated repeatedly and is correlated to comprehension with correlations of  $r = 0.62$ - $0.9$  between the FOG readability formula and reading comprehension.<sup>6</sup> This is also confirmed in recent studies by Dubay who found a correlation of  $r = 0.91$  between the FOG readability formula and comprehension as measured by reading tests.<sup>9</sup>

This mismatch between reading assessment skills and the readability levels of required readings was also found in a study of dietetic interns as reported by McCabe et al.<sup>11</sup> Since the amount of reading required by students is significant in pharmacy school, there may be an expectation by faculty members that all students possess advanced reading skills. This was not a finding in our study. The NDRT revealed that the students' reading ability of common text (non-medical) was less than anticipated even though these students have had 17-18 years of education.

As the number of applications for pharmacy schools increase, the use of NDRT scores during the admission process may be a viable option for schools of pharmacy to help identify students who are more academically prepared for pharmacy school. The NDRT can also be used during pharmacy students' academic careers to determine

which students may need additional help in reading more difficult material since it has been used to monitor the progress of student's reading abilities. Programs that teach students how to improve their ability to read highly technical material could be established for those students who score poorly on the NDRT.

The close correlation of the PCAT and NDRT scores, which were administered almost 4 years apart, implies that the PCAT does a good job of possibly predicting the reading skills of students. A future research project will involve the use of the NDRT each year to monitor students' progress through pharmacy school and document any association of reading skills with academic success and board passage rates.

### Limitations

The authors recognize limitations to this study. We realize that the NDRT is not commonly used by health science programs to assess the reading skills of their students. The NDRT uses general vocabulary terms and reading passages that pertain to humanities, social sciences, and general sciences. However, the NDRT has been used by some health science programs and has been found to predict academic success. Though the NDRT does not contain complex health science terminology, we believe that our students should have scored even higher on the NDRT given the lower complexity of the terminology and reading passages.

We administered the NDRT to P3 students (as opposed to P1 students). The subjects represented a convenience sample. We also wanted to simultaneously assess the readability of required readings. A concern among many faculty members who lecture in the P3 *Therapeutics* course is that not all assigned readings are completed. We decided to assess the reading abilities of the P3 class and the readability of their required reading materials. These included the *Pharmacotherapy* text used in the course<sup>15</sup> and required readings from the primary literature. We compared the NDRT in P3 students to their PCAT scores which were administered prior to entering the P1 year.

Although the results for the PCAT and NDRT are separated by almost 4 years, the significant correlations between them suggest that the PCAT scores may still have value in predicting vocabulary and reading abilities and that both instruments may be measuring similar characteristics. Although the findings of this study are limited to the Campbell University School of Pharmacy, we believe that other schools should evaluate this topic and consider how this can influence the admissions process and the development of programs for students who may need academic assistance in pharmacy school.

Readability tests do not take into consideration the background knowledge of the reader and the types of materials they are accustomed to reading. As faculty members, we may assume that pharmacy students are prepared to read complex material that is required for a course regardless of student background knowledge. However, just because the FOG readability formula rated the materials at a higher grade level (18-19 years) than the NDRT assessed our students (16.5 years), this does not necessarily mean that the students can not understand the materials. This study only shows that our students' NDRT reading scores are lower than the reading levels believed necessary for adequate comprehension of the reading material.

Another limitation is that only selected chapters from *Pharmacotherapy: A Pathophysiologic Approach*<sup>15</sup> and selected published medical treatment guidelines<sup>16-21</sup> were used. Readability scores may have varied if additional chapters out of the textbook and guidelines from the literature had been assessed. Furthermore, the Gunning FOG readability formula has been used in past studies for the analysis of medical content, but it has not been validated on technical material. However, the scores from this study are very similar to the scores that were obtained in studies that assessed the readability of medical journals.<sup>6,7</sup>

## CONCLUSIONS

In conclusion, this study showed that some students in the P3 class at CUSOP may have difficulty reading and understanding their required reading assignments. Future research should include similar studies of pharmacy students at various stages of the curriculum, the relationship between NDRT reading scores and such variables as academic achievement and PCAT scores, and methods to enhance student reading abilities.

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